University of Tripoli - Faculty of Engineering
Department of Electrical and Electronics Engineering

EE302 Signals and Systems

Final Exam, Fall 2017, 04 February 2018, Time allowed: 3:00*h*

أسم الطالب: ....

رقم القيد: ....

Answer the following Questions

Q1)

[2] **i)** Determine the correct type of each signal, justify your answer.

Signal	Energy signals, power signals or neither?	Why?
$x(t) = \cos\left(\frac{\pi}{3}t - \frac{\pi}{4}\right)$		
$x[k] = (-0.2)^k u[k]$		

[3] **ii)** Determine whether or not each of the following signals is periodic. If a signal is periodic, determine its fundamental period and the harmonics present in x(t).

Signal	Periodic?	ω_0	Harmonics present
$\cos\left(\frac{\pi}{3}t - \frac{\pi}{4}\right) + \sin\left(\frac{2\pi}{3}t\right)$			
$\cos\left(\frac{1}{5}k\right) + \cos\left(\frac{1}{4}k\right) + \cos(\frac{1}{2}k)$			

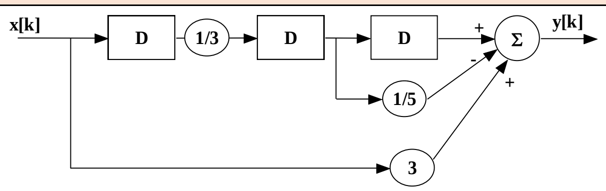
[3] **iii)** Determine the properties of each systems (Yes or No)

System	Linear?	Casual?	Time-Invariant?	Invertible?	inverse system
$y(t) = 2x^2(t)$					
y[k]=k x[k]					
y[k] = 8 x[k]					

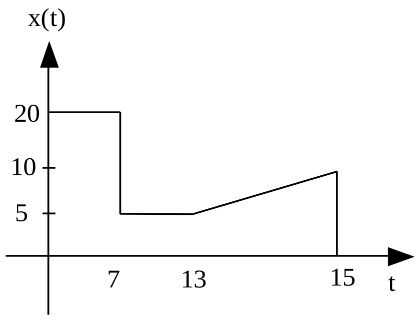
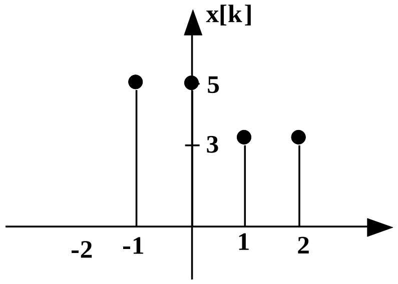
[3] **iv)** Evaluate the following integrals

$\int_1^2 (2t - 1)\, \delta(t) dt$	
$\int_{-2}^2 exp(2t)\, \delta(t-1) dt$	

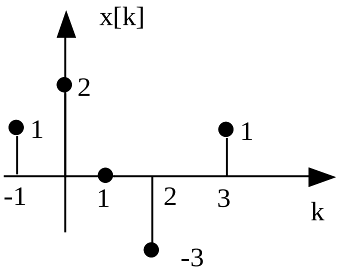
[3] **v)** Find the impulse response of the given discrete system

	impulse response
	

[3] **vi)** Express the signals shown in terms of unit step functions

[4] **vii)** For each signal x[k], sketch of the corresponding signal transformation.

$x[k]$	$x[-k+3]$	$x[2k-2]$
		

[3] **viii)** Find the Fourier Transform of the following signals.

$3\cos(30t-2)+2\cos(50t+2)$	
$3+4\delta(t+4)-8\delta(t-3)$	

[3] **ix)** Find the Laplace Transform of the following signals.

$2(\mathrm{t}-5)\mathrm{u}(\mathrm{t}-5)$	
$3\mathrm{u}(\mathrm{t}-1)+\delta(t-1)$	

[3] **x)** Determine if the following systems stable or unstable, justify your answer

	Stable?	Why?
$y''(t)-1.5y'(t)+y(t)=0$		
$y[k+2]-0.5y[k+1]+y[k]=0$		

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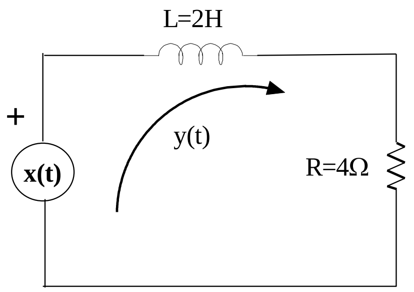
[5] **Q2** – Compute the output y(t) for a continuous-time LTI system whose impulse response h(t) and the input x(t) are given by

$$h(t) = 2u(t-2) - 2u(t-3) \qquad \mathrm{x}(t) = 3u(t+1) - 3u(t-2)$$

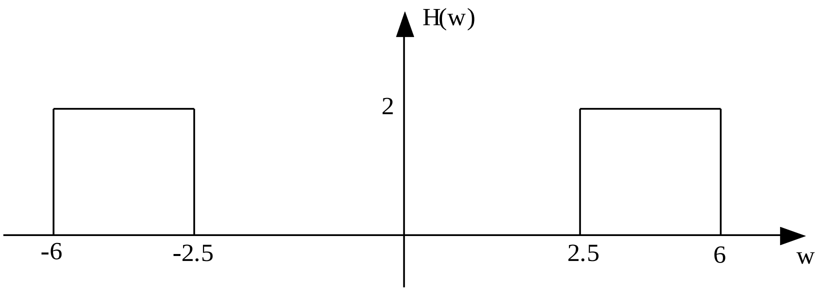
[5] **Q3** – Use Laplace Transform to find the current y(t) for the shown RC circuit if the input voltage x(t) is: a) x(t) = 5 δ(t) b) $\mathrm{x}(t) = 3e^{-5t}u(t)$



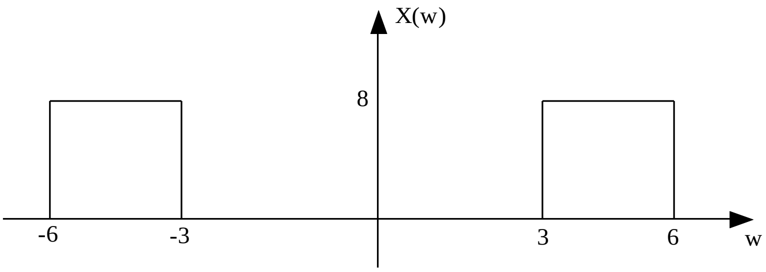
[5] **Q4** – Given the input signal x(t)= cos(2t) sin(3t).

a) Find the exponential Fourier series

b) Find the output signal y(t) if the input applied at the input of an LTIC system with the shown frequency response



[5] **Q5** – Use frequency-shifting property to find and sketch the inverse Fourier transform of the shown spectra



Good luck

TABLE 4.1 A Short Table of (Unilateral) Laplace Transforms

No.	$x(t)$	$X(s)$
1	$\delta(t)$	1
2	$u(t)$	$\frac{1}{s}$
3	$tu(t)$	$\frac{1}{s^2}$
4	$t^n u(t)$	$\frac{n!}{s^{n+1}}$
5	$e^{\lambda t}u(t)$	$\frac{1}{s-\lambda}$

$$\underbrace{\text{rect}\left(\frac{t}{\tau}\right)}_{x(t)} \Longleftrightarrow \underbrace{\tau\,\text{sinc}\left(\frac{\omega\tau}{2}\right)}_{X(\omega)}$$

TABLE 7.1 Fourier Transforms

No.	$x(t)$	$X(\omega)$
1	$e^{-at}u(t)$	$\frac{1}{a+j\omega}$
2	$e^{at}u(-t)$	$\frac{1}{a-j\omega}$
3	$e^{-a\|t\|}$	$\frac{2a}{a^2+\omega^2}$
4	$te^{-at}u(t)$	$\frac{1}{(a+j\omega)^2}$
5	$t^n e^{-at}u(t)$	$\frac{n!}{(a+j\omega)^{n+1}}$
5	$t^n e^{-at}u(t)$	$\frac{n!}{(a+j\omega)^{n+1}}$
6	$\delta(t)$	1
7	1	$2\pi\delta(\omega)$
8	$e^{j\omega_0 t}$	$2\pi\delta(\omega-\omega_0)$
9	$\cos\omega_0 t$	$\pi[\delta(\omega-\omega_0)+\delta(\omega+\omega_0)]$
10	$\sin\omega_0 t$	$j\pi[\delta(\omega+\omega_0)-\delta(\omega-\omega_0)]$
11	$u(t)$	$\pi\delta(\omega)+\frac{1}{j\omega}$

$x(t)$	$X(\omega)$
$kx(t)$	$kX(\omega)$
$x_1(t)+x_2(t)$	$X_1(\omega)+X_2(\omega)$
$x^*(t)$	$X^*(-\omega)$
$X(t)$	$2\pi x(-\omega)$
$x(at)$	$\frac{1}{\|a\|}X\left(\frac{\omega}{a}\right)$
$x(t-t_0)$	$X(\omega)e^{-j\omega t_0}$
$x(t)e^{j\omega_0 t}$	$X(\omega-\omega_0)$
$x_1(t)*x_2(t)$	$X_1(\omega)X_2(\omega)$

$$e^{\pm jx} = \cos x \pm j\sin x$$
$$\cos x = \tfrac{1}{2}[e^{jx}+e^{-jx}]$$
$$\sin x = \tfrac{1}{2j}[e^{jx}-e^{-jx}]$$
$$\cos\left(x\pm\tfrac{\pi}{2}\right) = \mp\sin x$$
$$\sin\left(x\pm\tfrac{\pi}{2}\right) = \pm\cos x$$
$$2\sin x\cos x = \sin 2x$$
$$\sin^2 x+\cos^2 x = 1$$
$$\cos^2 x-\sin^2 x = \cos 2x$$
$$\cos^2 x = \tfrac{1}{2}(1+\cos 2x)$$
$$\sin^2 x = \tfrac{1}{2}(1-\cos 2x)$$

$$\sin(x\pm y) = \sin x\cos y \pm \cos x\sin y$$
$$\cos(x\pm y) = \cos x\cos y \mp \sin x\sin y$$
$$\tan(x\pm y) = \frac{\tan x\pm\tan y}{1\mp\tan x\tan y}$$
$$\sin x\sin y = \tfrac{1}{2}[\cos(x-y)-\cos(x+y)]$$
$$\cos x\cos y = \tfrac{1}{2}[\cos(x-y)+\cos(x+y)]$$
$$\sin x\cos y = \tfrac{1}{2}[\sin(x-y)+\sin(x+y)]$$